2.0 INTRODUCTION

2.1 BACKGROUND

Following the 1996 fuel tank explosion-related accident on a 747 airplane, the FAA initiated rulemaking to re-evaluate the industry's approach to fuel tank safety by precluding ignition sources within the fuel tanks of the transport airplane fleet. The FAA also tasked the Aviation Rulemaking Advisory Committee (ARAC) with a 6-month project to provide specific recommendations and propose regulatory text for rulemaking that would significantly reduce or eliminate the hazards associated with explosive fuel vapors in transport airplanes.

In its July 1998 report, the ARAC provided a detailed evaluation of past accidents and incidents and recommended regulatory text for new rulemaking applicable to future transport airplane certifications. Because of the short time allowed to complete the task, the ARAC was unable to provide the detailed information necessary to recommend regulatory text applicable to existing in-service and current production airplanes. The ARAC did recommend that the FAA further investigate the feasibility of what it determined to be the two most promising methods:

1. **Directed ventilation.** Provides for ventilation of the areas adjacent to certain heated tanks to reduce heating within those tanks.
2. **Ground inerting.** Inerts the fuel tanks during ground operations.

On June 6, 2000, the FAA proposed the formation of an ARAC Fuel Tank Inerting Harmonization Working Group (FTIHWG). The group's purpose was to prepare a report for the FAA that (1) recommended regulatory text for new rulemaking and that (2) provided the necessary data for the FAA to evaluate the options involved in the introduction of fuel tank inerting systems that would significantly reduce or eliminate the development of flammable vapors in transport category airplane fuel tanks.

2.1.1 Scope

The historical approach to fuel system safety has been to control risk by ensuring that ignition sources are not present within the tanks. All current regulation and commercial airplane design is based on this philosophy. Going beyond this philosophy, the ARAC FTIHWG was given the task of recommending new rulemaking that would further enhance safety by eliminating or significantly reducing the presence of flammable fuel-air mixtures in fuel tanks.

As part of the ARAC Tasking Record for "Fuel Tank Inerting for Transport Airplanes," the FAA included the following Tasking Statement. (The complete FAA Tasking Statement for the FTIHWG is shown in appendix A).

2.1.2 Tasking Statement

The ARAC Executive Committee will establish a Fuel Tank Inerting Harmonization Working Group. The Fuel Tank Inerting Harmonization Working Group will prepare a report to the FAA/JAA that provides data needed for the FAA to evaluate the feasibility of implementing regulations that would require eliminating or significantly reducing the development of flammable vapors in fuel tanks on in-service, new-production, and new-type-design transport-category airplanes. This effort is an extension of the previous work performed by the Fuel Tank Harmonization Working Group.

The report should contain a detailed discussion of the technical feasibility of the prevention of, or reduction in, the exposure of fuel tanks to a flammable environment through the use of the following inerting design methods, and any other inerting methods determined by the Working Group, or its individual members, to merit consideration.

Ground-Based Inerting*—The system shall inert fuel tanks that are located near significant heat sources or do not cool at a rate equivalent to an unheated wing tank using ground-based nitrogen gas supply equipment. The affected fuel tanks shall be inerted once the airplane reaches the gate and while the airplane is on the ground between flights.*

Onboard Ground-Inerting*—The system shall inert fuel tanks that are located near significant heat sources or are not cooled at a rate equivalent to an unheated wing tank using onboard nitrogen gas generating equipment. The affected fuel tanks shall be inerted while the airplane is on the ground between flights.*

Onboard Inert Gas Generating System (OBIGGS)*—The system shall inert all fuel tanks with an onboard nitrogen gas generating system such that the tanks remain inert during normal ground and typical flight operations. Non-normal operations are not to be included in the OBIGGS mission requirements. For example, the tanks should remain inert during normal takeoff, climb, cruise, descent, landing, and ground operations (except for ground maintenance operations when the fuel tank must be purged for maintenance access); however, the fuel tanks do not need to remain inert during non-normal operations such as during an emergency descent.*

The report shall provide detailed discussion of technical considerations (both pro and con), as well as comparisons between each of the above design methods for incorporation into the following portion of the large transport airplane fleet: (a) in-service airplanes, (b) new-production airplanes, and (c) new airplane designs. Because the working group may consist of members having differing views regarding the feasibility of inerting fuel tanks, the report should include discussion of such views and any supporting information provided by the membership.

In developing recommendations to the FAA/JAA, the report should also include consideration of the following:

1. *The threat of fuel tank explosions used in the analysis should include explosions due to internal and external tank ignition sources for the major fuel system designs making up the transport fleet, as defined in the July 1998 ARAC Fuel Tank Harmonization Working Group report. The service history in the analysis should be further developed to include incidents involving post-crash fuel tank fires. The FAA awarded a research contract to develop a database that may be useful in this endeavor. This data should be evaluated when determining what benefits may be derived from implementing ground-based or onboard inerting systems. The report is titled, A Benefit Analysis for Nitrogen Inerting of Airplane Fuel Tanks Against Ground Fire Explosion, Report Number DOT/FAA/AR-99/73, dated December 1999.*
2. *The evaluation of ground-based inerting should consider:*
   a. *The benefits and risks of limiting inerting of fuel tanks to only those times when conditions, such as lower fuel quantities or higher temperature days, could create flammable vapors in the fuel tank. This concept would be analogous to deicing of airplane when icing conditions exist.*
   b. *Various means of supplying nitrogen (i.e., liquid, gaseous separation technology; centralized plant and/or storage with pipeline distribution system to each gate, individual trucks to supply each airplane after refueling, individual separation systems at each gate, and so on), and which means would be most effective at supplying the quantity of nitrogen needed at various airports within the United States and, separately, other areas of the world.*
   c. *Methods of introducing the nitrogen gas into the affected fuel tanks that should be considered include displacing the oxygen in fuel tanks with nitrogen gas, saturating the fuel*

with nitrogen in ground storage facilities (for example, in the trucks or central storage tanks), injecting nitrogen directly into the fuel as the fuel is loaded onto the airplane, and combinations of methods.

3. *The evaluation of the cost of an OBIGGS for application to new type designs should assume that the design can be optimized in the initial airplane design phase to minimize the initial and recurring costs of a system.*
4. *Evaluations of all systems should include consideration of methods to minimize the cost of the system. For example, reliable designs with little or no redundancy should be considered, together with recommendations for dispatch relief authorization using the master minimum equipment list (MMEL) in the event of a system failure or malfunction that prevents inerting one or more affected fuel tanks.*
5. *Information regarding the secondary effects of utilizing these systems (i.e., increased extracted engine power, engine bleed air supply, maintenance impact, airplane operational performance detriments, dispatch reliability, and so on) must be analyzed and provided in the report.*
6. *In the event that the working group does not recommend implementing any of the approaches described in this tasking statement, the team must identify all technical limitations for that system and provide an estimate of the type of improvement in the concept (i.e., manufacturing, installation, operation and maintenance cost reduction, and so on; and/or additional safety benefit required) that would be required to make it practical in the future.*
7. *In addition, guidance is sought that will describe analysis and/or testing that should be conducted for certification of all systems recommended.*

Unless the working group produces data that demonstrates otherwise, for the purposes of this study a fuel tank is considered inert when the oxygen content of the ullage (vapor space) is less than 10% by volume.

The ground-based inerting systems shall provide sufficient nitrogen to inert the affected fuel tanks while the airplanes are on the ground after landing and before taking off for the following flight. In addition to the ground equipment requirements and airframe modifications required for the nitrogen distribution system, any airframe modifications required to keep the fuel tank inert during ground operations, takeoff, climb, and cruise, until the fuel tank temperatures fall below the lower flammability range, should be defined.

The onboard ground inerting systems shall be capable of inerting the affected fuel tanks while the airplane is on the ground after touchdown and before taking off for the following flight. As for the ground-based inerting system, in addition to the inert gas supply equipment and distribution system, any airframe modifications required to keep the fuel tank inert during ground operations, takeoff, climb, and cruise, until the time the fuel tank temperatures fall below the lower flammability range, should be defined. Consideration should be given to operating the onboard inert gas generating system during some phases of flight as an option to installing equipment that might otherwise be necessary (e.g., vent system valves) to keep the fuel tank inert during those phases of flight, and as a cost tradeoff that could result in reduced equipment size requirements.

The data in the report will be used by the FAA in evaluating if a practical means of inerting fuel tanks can be found for the in-service fleet, new-production airplanes, and new airplane designs. The FAA may propose regulations to further require reducing the level of flammability in fuel tanks if studies, including this ARAC task and independent FAA research and development programs, *indicate that a means to significantly reduce or eliminate the flammable environment in fuel tanks, beyond that already proposed in Notice of Proposed Rulemaking (NPRM) 99-18, is practical. Such a proposal would be consistent with the recommendations made by the ARAC Fuel Tank Harmonization Working Group in their July 1998 report.*

2.1.3 Charter

The charter of the ARAC FTIHWG has been to

1. Analyze
   - The technical considerations as well as comparisons between the various fuel tank inerting design methods for incorporation into the large transport fleet.
   - The threat of fuel tank explosions due to internal and external tank ignition sources for the major fuel system designs making up the transport fleet.
   - Various design methods of eliminating or significantly reducing exposure to flammable fuel vapors within fuel tanks.
   - Means to eliminate the resultant hazard if ignition does occur.
2. Recommend regulatory text and guidance material for new rulemaking if a practical means of inerting fuel tanks can be found.
3. Assess the cost benefit of those systems.
4. Assess the effect of the new rule on other sections of the industry.
5. Follow the rules for ARAC harmonization working groups.
6. Issue a final report within 12 months after publication of the Tasking Statement.

2.2 WORKING GROUP DEVELOPMENT

On July 13, 2000, the FAA issued a notice in the *Federal Register* in Washington, D.C., establishing the current FTIHWG. This effort is an extension of the previous work performed by the 1998 ARAC Fuel Tank Harmonization Working Group (FTHWG), as reported in July 1998. The FTIHWG will coordinate with other working groups, organizations, and specialists, as necessary.

The FTIHWG addressed the following inerting systems:

- Ground-based inerting (GBI).
- Onboard ground inerting (OBGI).
- OBIGGS.

The FTIHWG addressed the following groups of transport category airplanes:

- In-service airplanes.
- New production airplanes.
- New airplane designs.
- Commuter airplanes.
- Short-range, medium-range, and intercontinental-range airplanes.

2.2.1 Organization

Figure 2-1 shows the organization of the ARAC FTIHWG leadership team.

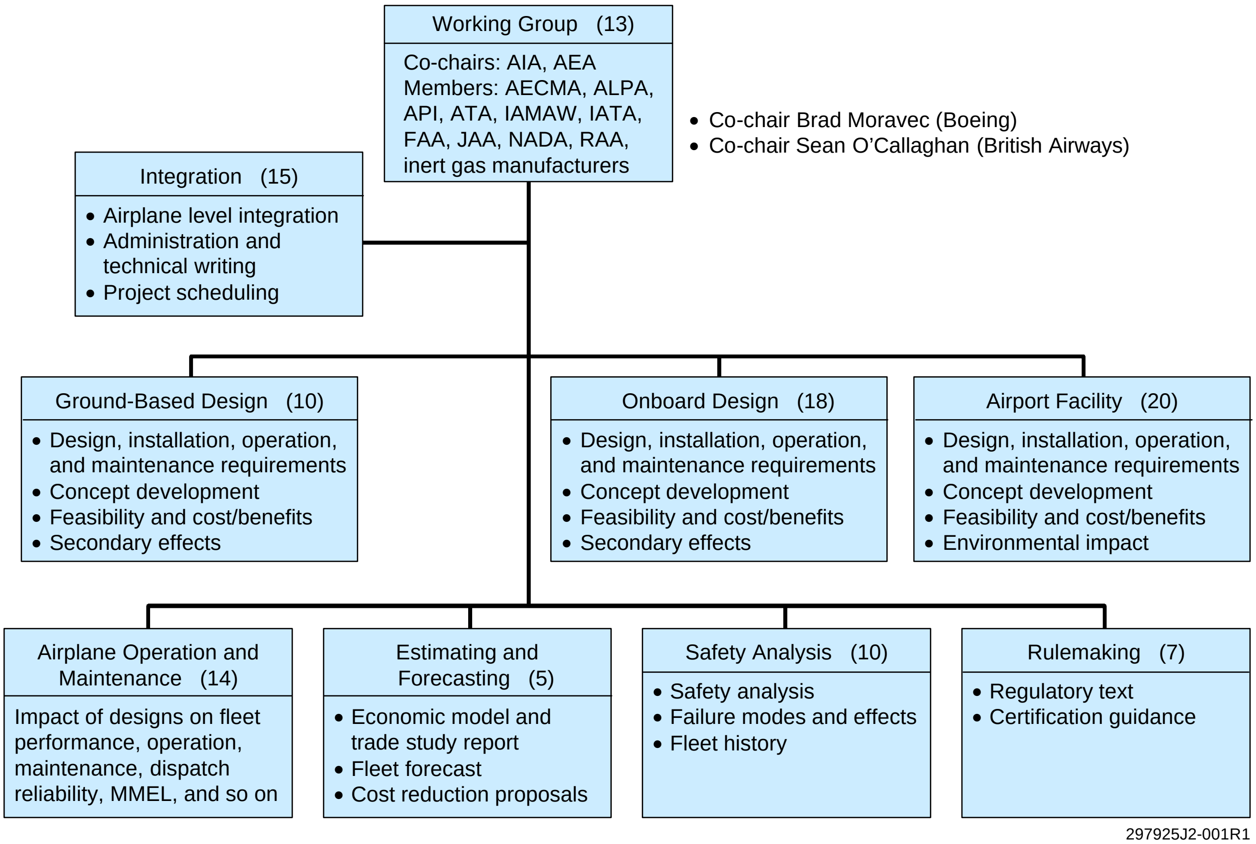

Figure 2-1. Working Group Team Leaders

2.2.2 Task Team Charters and Deliverables

Work Plan Outline

- The FTIHWG will be responsible for overall task management.
- Task management will include overall definition of study ground rules, success criteria, work statements, plans, schedules, resources, and deliverables.
- The FTIHWG will establish task teams to assist in completing the various tasks identified in the Tasking Statement issued in Washington, D.C., by the FAA, dated July 10, 2000.

Task Teams

- Ground-Based Inerting Designs
- Onboard Inerting Designs
- Airplane Operation and Maintenance
- Airport Facility
- Safety Analysis
- Estimating and Forecasting
- Rulemaking
- Integration

Task Team Responsibilities

Ground-Based Inerting Designs

- Review existing data on GBI studies and systems.
- Determine design, installation, operation, and maintenance requirements.
- Develop ground-based conceptual fuel tank inerting system designs.
- Provide a feasibility analysis of proposed designs and inerting methods.
- Prepare a cost-benefit analysis for ground-based system concepts.
- Evaluate the safety, risks, and secondary effects of these systems.
- If the concept is considered impractical, identify all technical limitations and provide an estimate of improvements necessary to make this concept practical in the future.
- Document the results of the GBI design and analysis study.

Onboard Inerting Designs

- Review existing data on onboard inerting studies and systems.
- Evaluate three system concepts consisting of an onboard ground inerting system (OBGIS), an OBIGGS, and a hybrid system.
- Determine design, installation, operation, and maintenance requirements.
- Develop onboard conceptual fuel tank inerting system configurations.
- Provide a feasibility analysis of proposed designs and inerting methods.
- Prepare a cost-benefit analysis for inerting system concepts.
- Evaluate the safety, reliability, risks, and secondary effects of these systems.
- If this concept is considered impractical, identify all the technical limitations and provide an estimate of improvements necessary to make the concept practical.
- Document the results of the onboard inerting design and analysis study.

Airplane Operation and Maintenance

- Review existing data on the impact of fuel tank inerting studies and systems on airplane operation and maintenance activities.
- Evaluate the impact of the proposed ground and onboard inerting system concepts on flight operations (such as dispatch reliability, air turnback [ATB], dispatch deviation guide [DDG], and master minimum equipment list [MMEL]).
- Evaluate the impact of inerting system concepts on maintenance operations and the subsequent effect of these concepts on fleet performance.
- Evaluate the cost impact of the inerting system concepts on flight operations, maintenance operations, fleet planning, and so on.
- Document the results of the Airplane Operation and Maintenance Task Team.

Airport Facility

- Review existing data on the impact of fuel tank inerting studies and systems on airports.
- Determine which airports within the United States and in other geographical areas of the world should be included in the study.
- Define the design, installation, operational, and maintenance requirements for inert gas generation, fuel scrubbing, and ullage washing.
- Develop conceptual system configurations to provide fuel-scrubbing and ullage-washing systems that can be used at airports considered in this study.

- Evaluate the impact on airport facilities and infrastructure that would result from the incorporation of the inerting system concepts being considered.
- Determine the most reliable and cost-effective means of providing inerting supplies within the United States and in other areas of the world.
- If system concepts are not practical, identify all technical limitations and estimate what improvements would be necessary to make the concepts practical.
- Document the results of this airport facility and infrastructure study.

Safety Analysis

- Review existing data regarding the safety benefits anticipated from eliminating or significantly reducing the threat of fuel tank explosion.
- Determine the safety benefits resulting from incorporation of the various proposed system concepts to eliminate or significantly reduce the development of flammable vapors in airplane fuel tanks.
- Evaluate the impact of these system concepts on previous service history fuel tank explosion threats resulting from internal and external tank ignition sources.
- Evaluate the risks and benefits of “as required” inerting system concepts.
- Document the results of the safety evaluations.

Estimating and Forecasting

- Review the available existing data regarding the economic impact of airplane fuel tank inerting studies and systems.
- Develop top-level models to assist the other task teams in evaluating the economic impact of the proposed inerting system concepts on airplane and aviation operations, airport facilities and infrastructure, and the general economy.
- Where practical, propose methods to minimize the overall system costs.
- Estimate the economic impact of the recommended systems on airline operations, the transportation industry, airport facilities and infrastructure, and regional and country economy.

Rulemaking

- Review existing regulations, advisory and guidance material, and continued airworthiness instructions regarding the subject of eliminating or reducing the flammable environment in airplane fuel tank systems.
- Prepare and coordinate within the FTIHWG regulatory text for new rulemaking by the FAA that would eliminate or significantly reduce the flammable environment in airplane fuel tank systems.
- For all system concepts recommended, develop and propose guidance material that describes the necessary analysis or testing that may be required to show compliance with the new regulatory text for certification and continued airworthiness.

Integration

- Review existing data from previous fuel tank working groups regarding applicability to the current tasks.
- Coordinate the development of task and system requirements for use by the FTIHWG.
- Coordinate activities within the FTIHWG to ensure that the task teams are using common ground rules, definitions, assumptions, requirements, schedules, and so on.
- Facilitate activities and communication within the FTIHWG to achieve the intermediate and final task assignments in a timely manner.

- Coordinate with other harmonization working groups, organizations, companies, and experts to support FTIHWG activities.
- Develop and implement a review process and integrated task schedule to support the requirements of the ARAC Executive Committee.
- Coordinate preparation of this final report to the ARAC Executive Committee.

Final Deliverables

- Recommend regulatory text for new rulemaking by the FAA that would require eliminating or significantly reducing the development of flammable vapors in fuel tanks on transport category airplanes; and provide compliance guidance material for the proposed regulation.
- Evaluate options for implementing these new regulations on current and future airplanes.
- Identify all technical limitations for those design options that are determined to be currently impractical.
- Provide guidance on testing and analysis for demonstrating certification compliance and continued airworthiness.
- Submit the above by June 29, 2001, for the ARAC Executive Committee to review before forwarding to the FAA.

2.2.3 Schedule

A milestone schedule was developed at the first FTIHWG meeting in September 2000.

The FTIHWG agreed to meet regularly according to a defined schedule. Individual task teams were directed to meet as often as necessary to accomplish the objectives of the FAA Tasking Statement. As stated, the final report is scheduled to be complete and delivered to the ARAC Executive Committee by June 29, 2001.

Figure 2-2 shows the task team schedule.

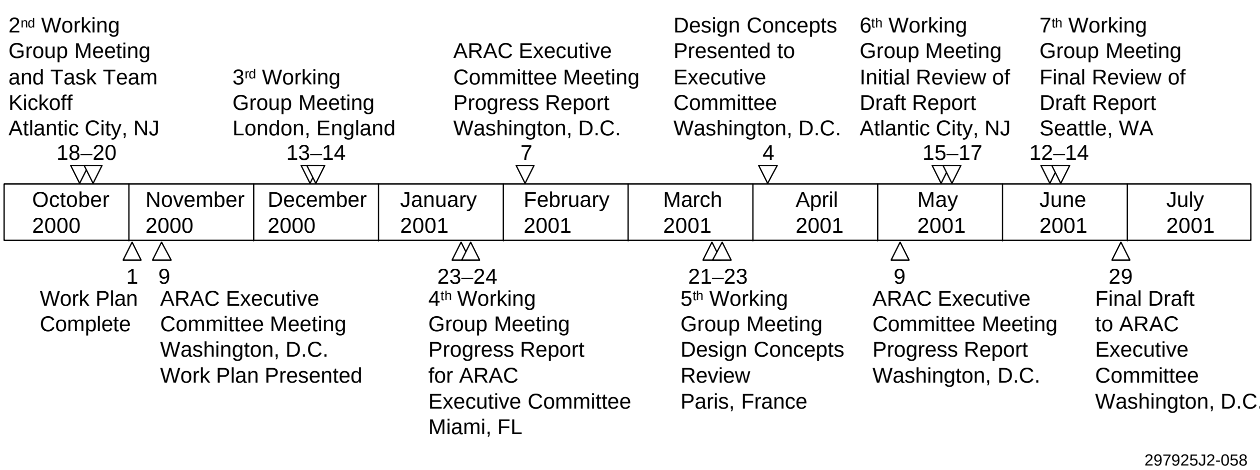

Figure 2-2. ARAC FTIHWG Major Milestones

2.3 STANDARDS

A common set of standards was necessary to achieve consistent results in the development and evaluation of designs and cost-benefit analyses. Therefore, the Integration Task Team developed and provided a common set of definitions for use by all the FTIHWG task teams.

2.3.1 Assumptions

To ensure that the potential methods of inerting were evaluated using consistent data and assumptions, a spreadsheet was created that provided a common source of data for use by the task teams. This spreadsheet included data for six generic airplane types: small, medium, and large jet transports; regional turbofans; regional turboprops; and business jets. The data included summaries for each airplane type, such as fleet size, weights, fuel volumes, and flight distributions. Mission profile data such as weight, altitude, Mach number, fuel remaining in each tank, and body angle as a function of time were included for each generic airplane type. Temperature profiles ranging from cold to extremely hot were also included in the mission profiles.

Performance and cost trade studies were included to allow consistent calculation of performance and cost impacts.

1. A fuel tank is considered inert when the oxygen content of the ullage (vapor space) is less than 10% by volume.
2. An unheated wing tank is defined as a conventional aluminum-structure integral tank of a subsonic wing with minimal heat input from airplane systems or other fuel tanks that are subject to heating.
3. The FTIHWG used the definition of fuel tank explosion threat contained in the July 1998 ARAC FTHWG report.
4. Service history used in this analysis was developed to include postcrash fuel tank fires.
5. Top-level design, reliability, maintenance, and operational study requirements were established to provide guidance for determining practical inerting systems.
6. In accordance with the Tasking Statement, design concepts evaluated had little or no redundancy in order to minimize costs.
7. Fuel tank inerting design concepts evaluated were not considered to be dispatch-critical systems and would therefore be part of the airplanes' MEL.

2.3.2 Ground Rules

The Working Group applied the following ground rules to the design concepts considered, as specified by the FAA Tasking Statement:

1. The FTIHWG evaluated the impact of fuel tank inerting design concepts or designs on transport category airplanes.
2. Within the transport category, the following "generic" study airplanes were evaluated:
   - Large-category airplanes.
   - Medium-category airplanes.
   - Small-category airplanes.
   - Commuter (turboprops and jets).
   - Business jets.
3. Within each airplane category studied, an evaluation was made of the impact on in-service airplanes, current new production, and future new type design airplanes.
4. FTIHWG task teams evaluated the impact of fuel tank inerting on airplanes with heated center wing tanks (CWT).
5. Where practical, the task teams used definitions, including the fuel tank explosion threat, developed for use and contained in the 1998 ARAC FTHWG Final Report.

6. The service history evaluated in FTIHWG studies and evaluations included postcrash fuel tank fires.
7. Fuel tank inerting design concepts considered by the FTIHWG have little or no system redundancy.
8. No fuel tank inerting system concept results in a net negative safety benefit to the airplane study category evaluated.
9. Fuel scrubbing with inert gas did not result in an adverse effect on fuel supply system performance, engine performance, or operational capability.
10. The FTIHWG identified technical and economic limitations of systems evaluated as impractical and estimated the improvements necessary to make these inerting systems practical in the future.
11. Except as noted in the report, the FTIHWG considered systems that would not result in a hazardous condition to personnel, airplanes, or airport facilities resulting from the failure of a fuel tank inerting system component during normal operation, nonnormal operation, or failure conditions.

Ground-Based Design Concepts Ground Rules

12. Each design concept proposed for a particular airplane study category must be capable of providing inert fuel tanks once the airplane reaches the gate and while the airplane is on the ground between flights.
13. It was considered unnecessary to evaluate any conditions within an airplane category's operational and environmental envelopes where a combination of fuel tank temperatures and quantities would not result in flammable vapors being present in any of the fuel tanks.
14. Failure of any fuel tank inerting system component during normal operations, nonnormal operations, and failure conditions will not result in a hazardous condition to any personnel, the airplane, or airport facilities.
15. Nitrogen-enriched air (NEA) that is supplied to the airplane during refueling operations for fuel tank inerting purposes is assumed to be a minimum of 95% purity.
16. The attachment panel or interface and the appropriate interface connections and equipment will not interfere with ingress and egress and the servicing position of ground equipment while the airplane is located at the terminal gate.
17. The location and design characteristics of the installed interface connections and equipment will not result in an additional hazard to the airplane as a result of a wheels-up landing.
18. No special provisions are included in the system design concepts to prevent air from entering the airplane fuel tank or inert gas from being vented from the airplane tank during any change in ground environmental thermal cycling.
19. The time taken by any ground-based design concept to inert the required number of fuel tanks in an airplane study category will not increase the turnaround time of that category.
20. The installation of a ground-based fuel tank inerting system will not result in an adverse effect on fuel supply system performance, engine performance, or engine operational capability.
21. During evaluation of a GBI system, consideration is given to the benefits and risks resulting from inerting only those fuel tanks located near significant heat sources.

Onboard Design Concepts (OBIGGS) Ground Rules

22. The OBGI design concept will be evaluated based on the ground rules defined in the section titled Ground Based Inerting Design Concepts.
23. Each design concept evaluated for a particular airplane study category is capable of providing inert fuel tanks during normal operations, such as takeoff, climb, cruise, descent, landing, and ground operations. However, nonnormal operations are not included in the ground rules in accordance with the Tasking Statement.
24. Each OBIGGS design concept is capable of inerting all fuel tanks in an airplane study category. (Reference: Tasking Statement.)
25. Any OBIGGS design concept installed will inert all fuel tanks throughout the certified airplane operating and environmental envelope during normal operation.

26. Where a combination of fuel tank temperatures and quantities shown within an airplane category's operational and environmental envelopes will not result in flammable vapors being present in any of the airplane fuel tanks, these conditions do not require fuel tank inerting from an onboard system.
27. The installation of an onboard fuel tank inerting system will not result in an adverse effect on the fuel supply system performance, engine performance, or engine operational capability.
28. Any certification maintenance requirements (CMR) or similar periodic maintenance checks required by an OBIGGS are considered to have a minimum frequency equivalent to a C-check.
29. When installed, an OBIGGS will not result in an increase of the schedule interruption rate of 0.05 per 100 departures in an airplane category. (Reference: industry experience.)
30. When installed, an OBIGGS will have an objective mature mean time between unscheduled removal (MTBUR) of any component of 5,000 hr minimum.
31. When installed, an OBIGGS will have a mature mean time between maintenance actions (MTBMA) of 250-hr minimum.

<u>Airplane Operation and Maintenance Ground Rules</u>

32. Regardless of the method of fuel tank inerting system used to inert the applicable fuel tanks in an airplane study category, the turnaround time of that particular airplane category will not be increased.
33. The operational and maintenance impact of continued airworthiness requirements of each fuel tank inerting system is estimated.

<u>Airport Facilities Ground Rules</u>

34. Any facilities developed to provide NEA for use in inerting airplane fuel tanks, while the airplane is located at the terminal gate, will meet all applicable safety regulations in force as of July 10, 2000.
35. Any system evaluated is capable of providing sufficient NEA to each airplane in a particular study airport so that the current airplane turnaround times are not adversely affected.
36. Any evaluated airport-based system for inerting fuel tanks will have adequate capacity to supply the required volume of nitrogen to each gate position in a period of time that will not result in an increase in the airplane turnaround time for that study-category airplane.
37. The airport-based fuel tank inerting system must be capable of simultaneously providing 100% of the flow requirements for each airport gate, taking into consideration the assumed mix of study-category airplanes at these terminal gates.
38. NEA supplied at the terminal gate for inerting airplane fuel tanks will be 95% minimum.

<u>Safety Ground Rules</u>

39. A functional safety hazard assessment will be performed for each ground-based or onboard inerting system evaluated. The basis for this report will be the functional hazard analysis (FHA) published by the 1998 ARAC FTHWG with appropriate changes to reflect the current evaluations.
40. A system reliability prediction will be completed for each ground-based and onboard design concept evaluated.
41. A system reliability prediction will be completed for each airport fuel tank inerting and fuel scrubbing system evaluated.
42. For the purposes of this study, the accident data set defined by the 1998 ARAC FTHWG will be used.
43. Any accident prevention analysis will consider report number DOT/FAA/AR-99/73. (Reference: Tasking Statement.)
44. A study was conducted on any proposed inerting design concept that estimated the accident prevention improvement of implementing that fuel tank inerting design concept. The methodology used for this study will be consistent with that used by the industry's Commercial Aviation Safety Team to evaluate intervention effectiveness.
45. Any fuel tank inerting design concept proposed that does not result in a positive net safety benefit will be considered unacceptable.

Estimating and Forecasting Ground Rules

46. Increases in airplane gate turnaround times will be assessed on an economic value of $150 million/min for U.S. operations and $380 million/min for worldwide operations. (Reference: Air Transport Association of America [ATA].)
47. The cost of fuel per U.S. gallon for this study will be $1.00. (Reference: *Air Transport World*, January 2001.)
48. Any estimated airplane flight delays resulting from operation of either a ground-based or onboard fuel tank inerting system will be assessed an economic value of $24.43/min. (Reference: ATA.)
49. Turnbacks to the departure airport or diversions to unscheduled landings at alternate en route airports will not be required for the system because the system will be eligible for MEL dispatch.
50. For each labor-hour estimated in the study, a burdened rate of $110/hr will be assumed for professionals (e.g., engineers). (Reference: FAA.)
51. For each labor-hour estimated in the study, a burdened rate of $75/hr will be assumed for technicians (e.g., line mechanics). (Reference: FAA.)
52. For each labor-hour estimated in the study, a burdened rate of $25/hr will be assumed for ground support personnel (e.g., refuelers). (Reference: FAA.)
53. The ramp-up time for introducing a certified fuel tank inerting system into the existing and current in-production fleets will be assumed to be 3 years for production models and an additional 7 years for in-service models.
54. The time period to be considered for calculating costs of an inerting scheme will be 16 years (from 2005 to 2020.)
55. The growth forecast assumed for the purposes of this study will be 3.6% per year. (Reference: ATA.)
56. Any increases or decreases in airline operations, direct airplane operating costs, and maintenance costs will be developed to determine the subsequent impact of fuel tank inerting on each study-category airplane and the overall operational impact.
57. For evaluation of costs of an OBIGGS for application to new type designs, it will be assumed that the design can be optimized in the initial design phase to minimize initial and recurring costs. (Reference: Tasking Statement.)

Rulemaking Ground Rules

58. A review of the current 14 CFR will be conducted to consider the changes that may be necessary for the incorporation of ground-based or onboard fuel tank inerting systems.
59. Where changes to the regulations are considered to be required, the FTIHWG will propose regulatory text for each paragraph that would require a change.
60. In support of any proposed regulatory changes, guidance material will be developed to describe analysis or testing that should be conducted for certification of all systems proposed.
61. For each fuel tank inerting design concept proposed, the recurring and nonrecurring costs to achieve complete FAA certification are estimated.

3.0
Service History